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(54) Polyester Multifilament and Production Process Thereof

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SPECIFICATION

1. Title of Invention
Polyester Multifilament and Production
Process Thereof
2. Claims
 - (1) A polyester multifilament comprizing filament group (I) which consists of one type selected from a group comprizing polyethylene terephthalate, polytrimethylene terephthalate and poly tetramethylene terephthalate, or the blend of a multiple number of polyesters and/or a copolymer; and filament group (II) in which one type selected from polyethylene terephthalate, polytrimethylene terephthalate and polytetramethylene terephthalate or the blend of a multiple number of polyesters and/or a copolymer is used as the matrix, and one type selected from a group comprizing a styrene-based polymer, methacrylate-based polymer and acrylate-based polymer or a multiple number of

polymers are added to the matrix in the amount of 0.4 ~ 8 % by weight of the weight of the matrix.

(2) The polyester multifilament as described in Claim 1 in which the average elongation at break of filament group (II) is greater than the average elongation at break of filament group (I).

(3) The polyester multifilament as described in Claim 1 in which the average single fiber denier of filament group (I) is not smaller than the average single fiber denier of filament group (II).

(4) The polyester multifilament as described in Claim 1 in which the number of filaments of filament group (I) is not greater than the number of filaments of filament group (II).

(5) The polyester multifilament as described in Claim 1 in which the total denier of filament group (I), De (I) and total denier of filament group (II), De (II) satisfy the following formula.

$$0.25 \leq \frac{\text{De (I)}}{\text{De (II)}} \leq 4$$

(6) A production process for a polyester multifilament characterized by the fact that each of polymer composition (I) comprising one type selected from a group which consists of polyethylene terephthalate, polytrimethylene terephthalate and polytetramethylene terephthalate, or a multiple number of polyesters; and polymer composition (II) in which one type selected from a group consisting of polyethylene terephthalate, polytrimethylene terephthalate and polytetramethylene terephthalate, or a multiple number of polyesters are used as the matrix, and one type selected from a group consisting of a styrene-based polymer, methacrylate-based polymer and acrylate-based polymer, or a multiple number of polymers are added to the matrix in the amount of 0.4 ~ 8 % by weight of the matrix weight is melted and discharged from separate discharging holes without mixing them and, after cooling, yarn doubling and take-up are carried out.

(7) The production process as described in Claim 6 in which the take-up rate of the spun yarn is set to no less than 2000 m/min.

(8) The production process as described in Claim 6 or 7 in which polymer composition (II) is discharged from discharging holes arranged in the outer periphery of the same spinning nozzle, and polymer composition (I) is discharged from discharging holes arranged in the inner periphery.

(9) The production process as described in Claim 6 in which the filament after yarn doubling is subject to the intertwinement treatment.

3. Detailed Description of the Invention

The present invention relates to a polyester multifilament, to be precise, a polyester multifilament which has a structural difference that causes a significant (incomprehensible word) between the constituent filaments when woolie finishing is done, or when drawing is carried out.

Variations in the structure and physical properties of individual single fibers of natural fiber, for example, wool or silk used for clothing have greater characteristics as compared to synthetic fiber. These variations should be regarded as advantageous rather than defective; as compared to fabrics from synthetic fiber, natural fiber has high bulge

and a feeling of softness, and (illegible) has strength. Therefore, study has hitherto been done to allow even synthetic fibers to have a denier difference and (incomprehensible word) intentionally between single fibers to form a mixed multifilament.

Currently, in order to obtain such a mixed multifilament, a method is generally used in which, after each of two types or more of multifilaments which have mutually different properties such as shrinkage, elongation and elasticity is spun separately, they are opened appropriately at the drawing process, false twisting process and other processes and mixed. While these methods are superior in the point that (incomprehensible) between filaments is easily adjusted, for the thin denier yarn of no more than 150 denier, especially no more than 75 denier which has particularly high demand in recent years as a silk-like or wool-like high quality exclusive material, required is a process to spin two types or more of multifilaments of denier thinner than the targeted one and, furthermore, to mix them. Hence there is a shortcoming of yarn-spinning cost increase and unprofitability.

For a method to control yarn-spinning cost and to impart between filaments a structural difference, physical property difference, denier difference and form difference, there is the spinning- filament combining method, which has also hitherto been investigated. In the said method, filament mixing is done in the spinning process. In this case there are a method with the same polymer and a method in which a multiple number of polymers with different viscosities and chemical structures are spun simultaneously.

In the former case of spinning and filament mixing using the same polymer, filament balls having different deniers, cross sections and physical properties are obtained by varying the amount discharged from each discharging hole of the spinning nozzle. In the said method, however, since cooling of a thick denier filament is delayed from cooling of a thin denier filament, the thick denier component becomes the component of low orientation and high elongation, and conversely the thin denier component becomes the component of high orientation and low elongation. When such multifilaments are subject to woolie finishing, a strong tension due to the thin denier component becomes operative. Hence the thin denier filament clusters in the central part of the processed yarn causing a shortcoming that the thick denier filament is isolated in the outer layer, and the said fabric ends up having a feeling of hardness and weak (illegible). Therefore, it becomes the feeling entirely different from a feeling of softness and strong (illegible) generally required for the silk-like or wool-like material.

For the above reasons, the method to spin a multiple number of polymers simultaneously becomes a promising means left to attain the above-mentioned objective. Nevertheless, the current status remains that in reality there are very few polymer combinations that develop a large physical property difference by spinning under the completely same condition. Furthermore, when special polymers are used there is a concern that the feeling that polyester possesses may get lost.

In view of the above-mentioned points the present inventors carried out investigation zealously on filament yarn that provides a feeling of softness and strong (illegible). As a result, the present inventors found that when a small amount of a polymer obtained from a monomer having a certain type of unsaturated bond was blended with polyester the micro structure and physical properties of the said polyester changed strikingly. Thus the present invention was achieved.

That is to say, according to the present invention, provided may be

(1) a polyester multifilament comprising filament group (I) which consists of one type selected from a group comprising polyethylene terephthalate, polytrimethylene terephthalate and polytetramethylene terephthalate, or the blend of a multiple number of polyesters and/or a copolymer; and filament group (II) in which one type selected from polyethylene terephthalate, polytrimethylene terephthalate and polytetramethylene terephthalate or the blend of a multiple number of polyesters and/or a copolymer is used as the matrix, and one type selected from a group comprising a styrene-based polymer, methacrylate-based polymer and acrylate-based polymer or a multiple number of polymers are added to the matrix in the amount of 0.4 ~ 8 % by weight of the weight of the matrix; and

(2) a production process for a polyester multifilament characterized by the fact that each of polymer composition (I) comprising one type selected from a group which consists of polyethylene terephthalate, polytrimethylene terephthalate and polytetramethylene terephthalate, or a multiple number of polyesters; and polymer composition (II) in which one type selected from a group consisting of polyethylene terephthalate, polytrimethylene terephthalate and polytetramethylene terephthalate, or a multiple number of polyesters are used as the matrix, and one type selected from a group consisting of a styrene-based polymer, methacrylate-based polymer and acrylate-based polymer, or a multiple number of polymers are added to the matrix in the amount of 0.4 ~ 8 % by weight of the matrix weight is melted and discharged from separate discharging holes without mixing them and, after cooling, yarn doubling and take-up are carried out.

In the present invention, filament group (I) consists of polymer composition (I) comprising any polyester of polyethylene terephthalate, polytrimethylene terephthalate and polytetramethylene terephthalate, or any combination of these polyesters. However, additives for various purposes including improvements in matting and dyeability, and static prevention may be contained in the copolymer or blend in the range below 10 % by weight with respect to the total amount of the said composition (I).

On the other hand, filament group (II) consists of polymer composition (II) in which any polyester of polyethylene terephthalate, polytrimethylene terephthalate and polytetramethylene terephthalate, or any combination of these polyesters are used as the matrix, and one type selected from a group comprising a styrene-based polymer, methacrylate-based polymer and acrylate-based polymer, or a multiple number of polymers are added to the matrix in the amount of 0.4 ~ 8 % by weight of the matrix weight. However, additives for various purposes including improvements in matting and dyeability, and static prevention may be contained in the copolymer or blend in the range below 10 % by weight with respect to the total amount of the said composition (II).

In the present invention, the important matter is that the average elongation at break of filament group (II) is greater than the average elongation at break of filament group (I). To one's surprise, when a straight chain compound having a bulky substituent in the side chain like the styrene-based, methacrylate-based and acrylate-based polymers is added to a polyester, the orientation of molecular chains of each filament decreases and stretching increases sharply. While this reason is not clear yet, it is surmised that, since the said polymer added has a unique chemical structure, it is subject to little stretching in the polymer matrix, and is dispersed as fine particles of no more than 500 angstrom in diameter. It is believed that, as this fine particle acts like a "roller" between microfibrils of the matrix polyester, the above-mentioned phenomena of decreasing orientation and increasing elongation occur.

Cited for preferable specific examples of the said polymers added may be polymers of styrene derivatives such as styrene, α -methylstyrene, p-methoxystyrene, vinyltoluene, chlorostyrene and dichlorostyrene; or polymers of methacrylate derivatives such as methyl methacrylate and ethyl methacrylate; or polymers of acrylate derivatives such as methyl acrylate and ethyl acrylate. Among them, preferable from the cost aspect are polystyrene and polymethyl methacrylate.

These polymers added must be contained in the amount of 0.4 ~ 8 % by weight with respect to the polyester matrix in filament group (II). When it is below 0.4 % by weight, the effects on decreasing orientation and increasing elongation can be observed with difficulty. On the other hand, when an amount as large as exceeding 8 % by weight is added, conversely the polymer added acts adversely, hence filament group (II) forms weak yarn. Consequently, the processing situations such as spinnability and processability deteriorate significantly, hence it is not desirable.

In the present invention, it is preferable that the average single fiber denier of filament group (I) be not smaller than the average single fiber denier of filament group (II). Since for the afore-mentioned reason filament group (I) in the present invention becomes a material of high orientation and low elongation, during drawing or processing a strong tension tends to be operative and it tends to cluster in the core of the multifilament. Consequently, when the single yarn denier of filament group (I) is smaller than that of (II), the feel of the fabric from the said multifilament becomes void of (illegible). Conversely, when the single yarn denier of filament group (II) is smaller than that of (I), the thick denier filament group forms the central part of the multifilament, and the thin denier filament group is arranged in the outer periphery. As a result, it approaches the targeted wool-like or silk-like quality.

Moreover, in the present invention, the thin denier filament group must cover the thick denier filament group. In this sense, the filament number of filament group (I) is preferably not greater than the filament number of (II). Furthermore, the total denier of filament group (I), De (I) and total denier of filament group (II), De (II) desirably satisfy the formula of

$$0.25 \leq \frac{\text{De (I)}}{\text{De (II)}} \leq 4$$

When the total denier ratio is within the above-mentioned range, the multifilament exhibits adequate bulge; when it is beyond the above-mentioned range the balance between filament groups (I) and (II) breaks down, and exhibition of bulge of the multifilament becomes weak.

The polyester multifilament of the present invention can be prepared with a process in which each of polymer composition (I) comprising one type selected from a group which substantially consists of polyethylene terephthalate, polytrimethylene terephthalate and polytetramethylene terephthalate, or a multiple number of polyesters; and polymer composition (II) in which one type selected from a group substantially consisting of polyethylene terephthalate, polytrimethylene terephthalate and polytetramethylene terephthalate, or a multiple number of polyesters are used as the matrix, and one type selected from a group consisting of a styrene-based polymer, methacrylate-based polymer and acrylate-based polymer, or a multiple number of polymers are added to the matrix in

the amount of 0.4 ~ 8 % by weight with respect to the matrix weight is melted and discharged from separate discharging holes without mixing them and, after cooling, yarn doubling and take-up are carried out.

Blending of the above-mentioned polyesters and adding a polymer to the polyester can be done with any method. For example, they may be done at the polymerization process; moreover, after various types of polymers are simultaneously melt mixed, extruded and cooled they may be cut off to make chips. Furthermore, after various types of polymers are mixed as chips, they may be melt spun as they are. In this case, in order to enhance kneading a screw type melt extruder is preferably used.

In the present invention, each of polymer compositions (I) and (II) may be discharged from a separate nozzle. However, in order to enhance filament mixing it is preferable that discharging be done from different discharging holes in the same spinning nozzle. However, in this case since the flow route of the polymer inside the pack becomes complicated it is desirable that polymer composition (II) be discharged from the discharging hole arranged in the outer periphery, and polymer composition (I) be discharged from the discharging hole arranged in the inner periphery.

When the polyester filament of the present invention is obtained the more preferable matter is to set the yarn take-up rate to no less than 2000 m / min. When the spinning rate is low, orientation hardly occurs in molecular chains in filament group (II), the styrene-based polymer, methacrylate-based polymer or acrylate-based polymer added does not act sufficiently as "roller" on molecular chain orientation of the polyester, and the action on filament group (I) by filament group (II) to decrease orientation and to increase elongation becomes insufficient.

In order to further enhance filament mixing between filaments in the polyester multifilament of the present invention, it is also preferable that polymer compositions (I) and (II) be discharged from separate discharging holes and, after cooling, yarn doubling be done and intertwinement be imparted between filaments with a high pressure air flow through the interlace nozzle.

As mentioned above, the present invention can produce a high value-added polyester multifilament with an extremely simple means, and its industrial significance is extremely great.

The present invention is described with examples of embodiment in the following.
Example 1

Polyethylene terephthalate having an intrinsic viscosity of 0.64 and containing 0.5 % of titanium oxide as a matting agent was used as polymer composition (I), and polymethyl methacrylate (PMMA) (Asahi Kasei Delpet 80 N) was blended in the state of chips with the said polyethylene terephthalate in the various proportions, and this blends were used as polymer composition (II).

Each composition was melt compressed with a screw type melt extruder having 25 mm in diameter and without mixing mutual flow route composition (II) was discharged as filament group (II) from 24 round cross section discharging holes (diameter 0.2 mm) arranged in the outer periphery of the same spinning nozzle, and composition (I) was discharged as filament group (I) from 8 round cross section discharging holes (diameter 0.3 mm) arranged in the inner periphery of the said nozzle.

Room temperature air was blown at a rate of 12 m / min to the said filament group with the cross blow spinning chimney installed 10 ~ 110 cm under the spinning nozzle to cool and solidify the filament group. Then, the filaments were further allowed to

intertwine mutually with the interlace nozzle installed 4.5 m below the spinning nozzle with a high pressure air flow of 1.5 kg/cm².

Subsequently, oil was imparted to the said filament group and taken up at various rates through two godet rollers. The average elongations at break of filament groups (I) and (II) of the taken-up yarn are shown in Table 1.

Table 1

No.	Spinning rate (m/min)	Filament group (I)		Filament group (II)			Note
		de/fil	Elongation (%)	PMMA Blend ratio (%)	de/fil	Elongation (%)	
1	1000	200/8	490	0	186/24	470	Comp. Ex.
2	"	"	"	2	"	600	Pres. invent'n
3	2000	140/8	280	0	130/28	270	Comp. Ex.
4	"	"	"	1	"	360	Pres. invent'n
5	"	"	"	2	"	440	"
6	3000	72/8	170	0	68/24	140	Comp. Ex.
7	"	"	"	0.2	"	165	"
8	"	"	"	0.6	"	260	Pres. Invent'n
9	"	"	"	1	"	300	"
10	"	"	"	2	"	365	"
11	"	"	"	3	"	390	"
12	"	"	"	5	"	460	"
13	"	"	"	7	"	480	"
14	"	"	"	9	"	270	Comp. Ex.

In Nos 1, 3, 6 and 7, since either PMMA is not blended or even if it is blended the amount is too small, the elongation at break of filament group (II) is lower than the elongation at break of filament group (I). In sample No. 14, since the amount blended was too large the yarn-spinning situation deteriorated significantly.

Samples Nos 2, 4, 5 and 8 ~ 13 are from the present invention; the elongation of filament group (II) can be made greater than the elongation of filament group (I) by blending an appropriate amount of PMMA.

Example 2

The friction false twisting machine was used to undertake drawing and false twisting on No. 6 and Nos 9 ~ 11 under the conditions of the drawing ratio of 18 fold, processing rate of 300 m/min, heater temperature of 170°C and friction disc circumferential speed of 600 m/min. In No. 6 filament group (II) clustered in the core

Seventy % by weight of polyethylene terephthalate having an intrinsic viscosity of 0.64 and containing 0.5 % of titanium oxide as matting agent and 30 % by weight of polytetramethylene terephthalate having an intrinsic viscosity of 0.86 were mixed in the state of chips to form composition (I). On the other hand, polystyrene (PS) (Asahi Dow Styron 475 D) was blended in the state of chips in the various proportions with polyethylene terephthalate having an intrinsic viscosity of 0.64 and containing 0.5 % of titanium oxide to form polymer composition (II).

Each of the above-mentioned compositions was used for yarn-spinning in the same way as Example 1. The average elongations at break of filament groups (I) and (II) in the taken-up yarn obtained are shown in Table 2.

Table 2

No.	Spinning rate (m/min)	Filament group (I)		Filament group (II)		
		de/f	Elong'n (%)	PS Blend ratio (%)	de/f	Elong'n (%)
1	2000	120/8	235	2	112/24	330
2	"	"	"	4	"	405
3	"	"	"	6	"	445
4	3800	60/8	79	2	56/24	136
5	"	"	"	4	"	173
6	5000	45/8	48	1	42/24	93
7	"	"	"	2	"	128

It can be seen that any of thin denier filament group (II) has a greater elongation than that of filament group (I).

Example 4

Polytetramethylene terephthalate having an intrinsic viscosity of 0.86 and containing 0.5 % of titanium oxide was used as polymer composition (I) and the material in which polyethyl acrylate (PEA) was blended in the state of chips in various proportions with the said polytetramethylene terephthalate was used as polymer composition (II).

Each composition of the above-mentioned was subject to yarn-spinning in the same way as Example 1 to obtain the results as shown in Table 3

No	Spinning rate (m/min)	Filament group (I)		Filament group (II)			Note
		d e / f	Elong'n (%)	PEA blend ratio (%)	d e / f	Elong'n (%)	
1	1000	150/8	280	0	140/24	240	Comp. Ex.
2	"	"	"	0.5	"	300	Pres. inv'n
3	"	"	"	1	"	370	"
4	"	"	"	2	"	460	"
5	2000	72/8	180	0	68/24	140	Comp. Ex.
6	"	"	"	1	"	225	Pres. inv'n
7	"	"	"	2	"	293	"
8	3000	63/8	91	0	58/24	82	Comp. Ex.
9	"	"	"	1	"	138	Present inv'n
10	"	"	"	2	"	197	"

It can be seen that, in samples Nos 2 ~ 4, 6, 7, 9 and 10 of the present invention, the elongations at break of thin denier filament group (II) are greater than those of thick denier filament group (I).

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